

Ovechkin AM

APPLICATION OF INFRARED THERMOGRAPHY IN DIAGNOSTICS OF ACUTE VIRAL INFECTIONS OF RESPIRATORY SYSTEM

ABSTRACT

The aim of the present research is demonstration of possibilities of infrared thermography in diagnostics of acute viral infections of respiratory system. Obtained data showed, that infrared thermography can detect these disease at early and pre-clinical stages. Method of thermovisual diagnostics is based on detection of two groups of symptoms. First group - reflex symptoms, is specific changes of temperature on the hands above reflex areas, connected with respiratory system. Second group – local symptoms on the chest and the back. At early and pre-clinical stages of acute viral infections the first group of symptoms can be detected only. On the course of developing of pathological process, formation inflammation areas and reaction of immune system the second group of symptoms becomes appear and some symptoms of the first group becomes disappear. These specificities of thermovisual result may been used for diagnostics of early and pre-clinical stages of acute viral infections of respiratory system, especially for screening diagnostics of population in epidemic situation. The present research is pilot.

Keywords:

Thermography, respiratory system, pulmonology, viral infection, influenza, epidemic, screening diagnostics, acupuncture

Early diagnostics of acute viral infections of respiratory system (AVIRS) is the very important problem of modern Epidemiology. Solving this problem could really close the problem of controlling on spreading the diseases and to perform adequate epidemiological control, which could restrict the dissemination of epidemics.

The problem of early diagnostics of AVIRS is extremely difficult because of three causes. First cause is clinical. Well-known, that in most cases AVIRS begins with latent stage, without any clinical manifestation or with minimal non-specific symptoms. That's why it's very difficult, often quite impossible to make diagnosis and, moreover, differential diagnosis at the early stage. As a rule, when patient come to doctor, he already has some clinical symptoms – i.e. patient come to doctor in clinical stage of disease.

Second cause is epidemiological. Pre-clinical, or hidden period of AVIRS diseases is non-equal and is dependent on specificities of the virus, as well as on general condition of patient. Thus, in dependence on individual specificities of the person, pre-clinical stage of influenza may varies from several hours up to 3-5 days. But just this stage – pre-clinical stage, is the most dangerous from the point of view of Epidemiology, because at this stage infected person disseminates maximal count of viruses into the external environment and is most dangerous for community.

Third cause is organization. AVIRS disseminates very fast and the time from the first cases to total epidemic may be several weeks only. Because of this fact, methods for early diagnostics of AVIRS must be fast, low-cost and applicable in large groups. In addition, these methods must be noninvasive (the best solution is non-contact) and its application must not restrict or violate the human's rights.

Infrared thermography satisfies these criteria. Thermography is non-contact medical examination, absolutely safe for patient and doctor, has no limitations and contra-indications, fast and low cost. Thermography of a certain part of the human body for detection of some specific disease takes several seconds, so this method may be used in epidemiological examination of large populations.

The aim of the current work is to demonstrate possibilities of infrared thermography in diagnostics of early stages of AVIRS. Current work is a result of long-year clinical experience of author in medical thermography (since 1985). Within this period more than 20 thousand patients with different diseases were examined, some of them had early, pre-clinical stages of AVIRS.

MATERIALS AND METHODS

The current research is based on the selected patients with early AVIRS diseases from several databases, collected by author since 1985. Totally, 156 such patients were found (102 female – 65 %, and 54 male – 35 %). Patient's age was vary from 1 year to 89 years and it's showed in table 1. Selection criteria to the group of “early stage of AVIRS” was followed-up clinical analysis of the disease and final diagnosis. In current research the final clinical

diagnosis were: AVIRS – 62 persons (40 %), influenza – 88 persons (56 %), in 6 cases (4 %) the diagnosis of viral interstitial pneumonia was made.

Table 1. Age distribution of patients (156 cases).

Age	< 5 years	5-16 years	17-25 years	26-45 years	45-60 years	> 61 years
Number of cases	18	31	30	53	16	8
Percent	11,5	19,9	19,2	34	10,3	5,1

Existence of non-specific clinical symptoms (fatigue, headache, muscular pain, weariness, perspiration) at the moment of thermovisual examination was detected in 51 patients (33 %), last 105 persons (67 %) had no any complains. In every cases of this group the general body temperature at the moment of thermovisual examination was in Norman range. Followed-up control for the patients showed, that the first clear clinical symptoms were appeared in 1-4 after thermography: next 1 day – in 41 cases (26 %), in 2 days – in 80 cases (51 %), in 3 – 20 persons (13 %) and in 4 or more days – 15 patients (10 %).

Infrared thermography examinations were performed using different devices, such as TV-03, “Raduga-3”, “Raduga-5”, TV-03K, TV-04. Technical parameters of these cameras are different, but all of them work in the same infrared spectral band, so thermograms are relative compatible. In present work thermograms of face, upper and lower extremities, chest and back were analyzed - totally about 1000 thermograms. Infrared images, received by TV-03 and “Raduga-3” devices, were analyzed qualitatively only, in other cases quantitative analysis was available by measuring the temperature differences between some points of thermogram.

RESULTS AND DISCUSSION

Comparative analysis of thermograms of patients with early stage of AVIRS showed a presence of two specific thermovisual symptoms. These symptoms are never appear in any different diseases.

First symptom – a specific hyperthermia on the forehead from the inner eye corner (fig.1) was found in 92 patients (59 %). Usually this hyperthermic line starts from the inner corner of the right (38 cases) or left (50 cases) eye and goes toward the hair border on the midline. In 4 cases symmetrical lines on the left and right sides of forehead were found. Temperature gradient between this line and midline was from 0,6 to 1,1 °C. Analysis of clinical manifestations at the moment of thermovisual examination showed, that 61 patients (66 %) had headache, muscular pain and numbness in the back and joints. The final clinical diagnosis in the group of patients were influenza (69 patients – 75 %) and AVIRS (23 patients – 25 %).

Second symptom – an appearance of warm points on the external surface of the upper extremities (fig.2) was detected in 58 patients (37 %). These points have relative big size, moderate temperature gradient (from 0,5 to 0,9 °C) and are located on the external surface of the hand and forearm. It's very interesting, that these points locate along the course of the “Large Intestine” acupuncture channel [1]. In most cases this symptom was found in both sides (38 cases), but in some cases one-side location was detected: right side (8 patients) or

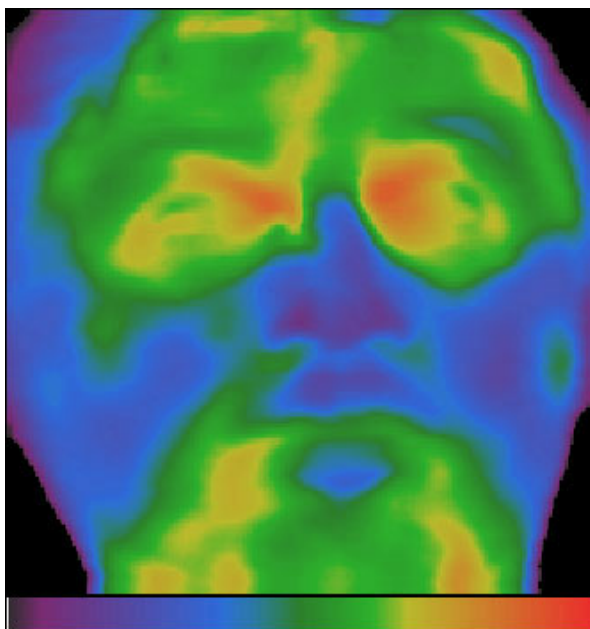


Fig.1. Hyperthermic line on the right side of forehead.

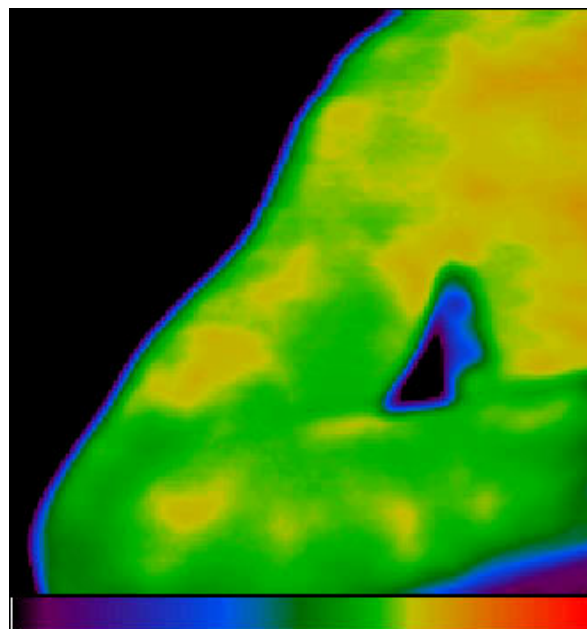


Fig.2. Hyperthermic points on the external surface of the right arm.

left side (12 patients). AT the moment of thermographic examination most patients had weakness, general warmth. Final clinical diagnosis in this group were influenza (19 cases – 33 %) and AVIRS (39 cases – 67 %).

It's necessary to point, that there no one case of simultaneous appearance of both above mentioned symptoms in one patient was detected. May be these symptoms indicates not a stage of one disease in patient, but rather the type, way of pathological process in current patient, which is more dependent on individual specificities of the patients, than on biological particularities of the viral agent.

Dynamic analysis of above mentioned specific thermographic symptoms showed, that during next 2-3 days they are disappearing, when new clinical symptoms, such as fever, cough, rhynitis, becomes appear.

Moreover, in 6 cases one another thermovisual symptom – hyperthermia of the external inner part of wrist skin folder, was detected (fig.3). This is an area of location of Tai-Yuan (LU.9) acupuncture point of the Lungs channel [1]. This point reflects the functional condition of the Lungs and hyperthermia on this points is often symptom of pneumonia [2, 3]. Without any doubt, this symptom is very important thermovisual sign, but it is not so strong specific for the early stages of AVIRS. It reflects the presence of inflammation into the lungs and a condition of protective power of the human body.

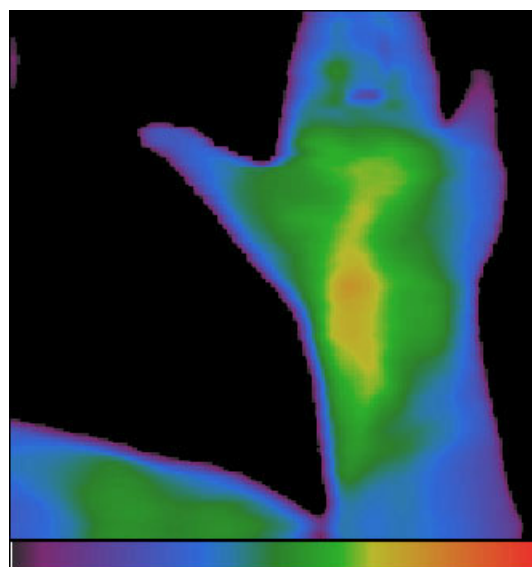


Fig.3. Hyperthermia above left Tai-Yuan (LU.9) acupuncture point in acute pneumonia.

In contrary with the two above mentioned symptoms, hyperthermia above Tai-Yuan acupoint does not disappear along the course of disease, sometimes it increase. This is indirect sign of condition of immune system of the patient and its reaction to the disease. Sometimes a transformation of this symptom takes place – in the beginning of disease Tai-Yuan acupuncture point was warm, but during the disease becomes cold. The cause of this phenomena and its importance for clinical medicine is a topic for further additional discussion.

Besides the above mentioned, along the course of disease another thermographic symptoms, such as spotted hyperthermia on the chest in the case of bronchitis, specific thermovisual symptoms of rhynitis, sinusitis and pneumonia become appear. Demonstration and discussion of these symptoms is out of the target of the current work. Demonstration and discussion of these symptoms is out of the present work and will be showed on further researches.

CONCLUSIONS

1. Two specific thermovisual symptoms – hyperthermic line on the forehead and spotted hyperthermia on the external surface of the arm, which can be detected regular in early pre-clinical stages of acute viral infections of respiratory system were found. These symptoms are no detected in other diseases.
2. These symptoms were detected in early stages of disease only. When another clinical symptoms of disease are appearing, above mentioned thermovisual symptom disappear.
3. First thermographic symptom (hyperthermic line on the forehead) more often was detected in influenza, second symptom – in other acute viral infections. But strong correlation between thermovisual symptoms and the type of viral agent was not found. It's supposed, that thermographic signs of disease are more dependent on individual reaction of the patient against infection, than on biological properties of virus.
4. Without any doubt, above mentioned specific thermovisual manifestations are connected with reaction of acupuncture system of the human body on disease. Because of this fact, thermographic examination may be used for diagnostics and differential diagnostics in Oriental medicine and may help to solve the problem of administration of the most adequate treatment.
5. This is obvious, that infrared thermography is a perspective and useful method for detection of acute viral infections of respiratory system at early stage. Many advantages of infrared thermography, such as non-contact, fast and low-cost, allow to use it for screening diagnostics of the population in epidemic situation. The most actual is application of infrared thermography in the places of high migration of the peoples, such as airports, railway stations.

6. To calculate the real diagnostics parameters of detected thermographic symptoms, such as sensitivity and specificity, is necessary to perform more large epidemiological research.

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AUTHOR:

Alexey Ovechkin

Thermography practitioner, Chief editor of "Medical Thermography"
Int.J.

P.O.Box 195, Nyzhny Novgorod, 603136, RUSSIA

Phone/fax +7-8312-686284

E-Mail: info@inframed.net

